Airspace Technology Demonstration 2 (ATD-2)

AOSP R&D Partnership Workshop
Apr 10, 2018

Agenda

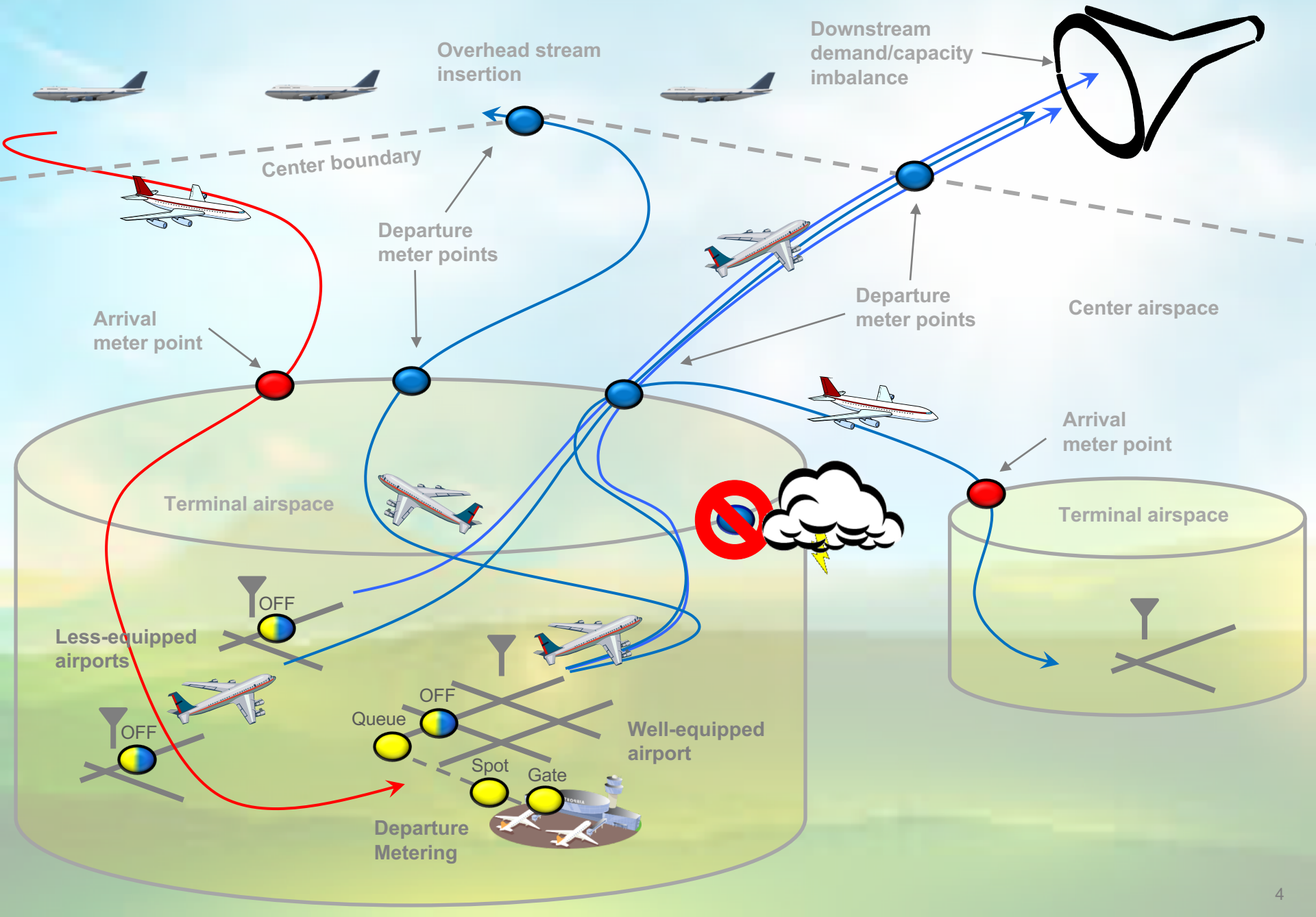
- **Introduction**
- IADS system architecture
- IADS system capabilities
- Partnership opportunities

Project Objectives†

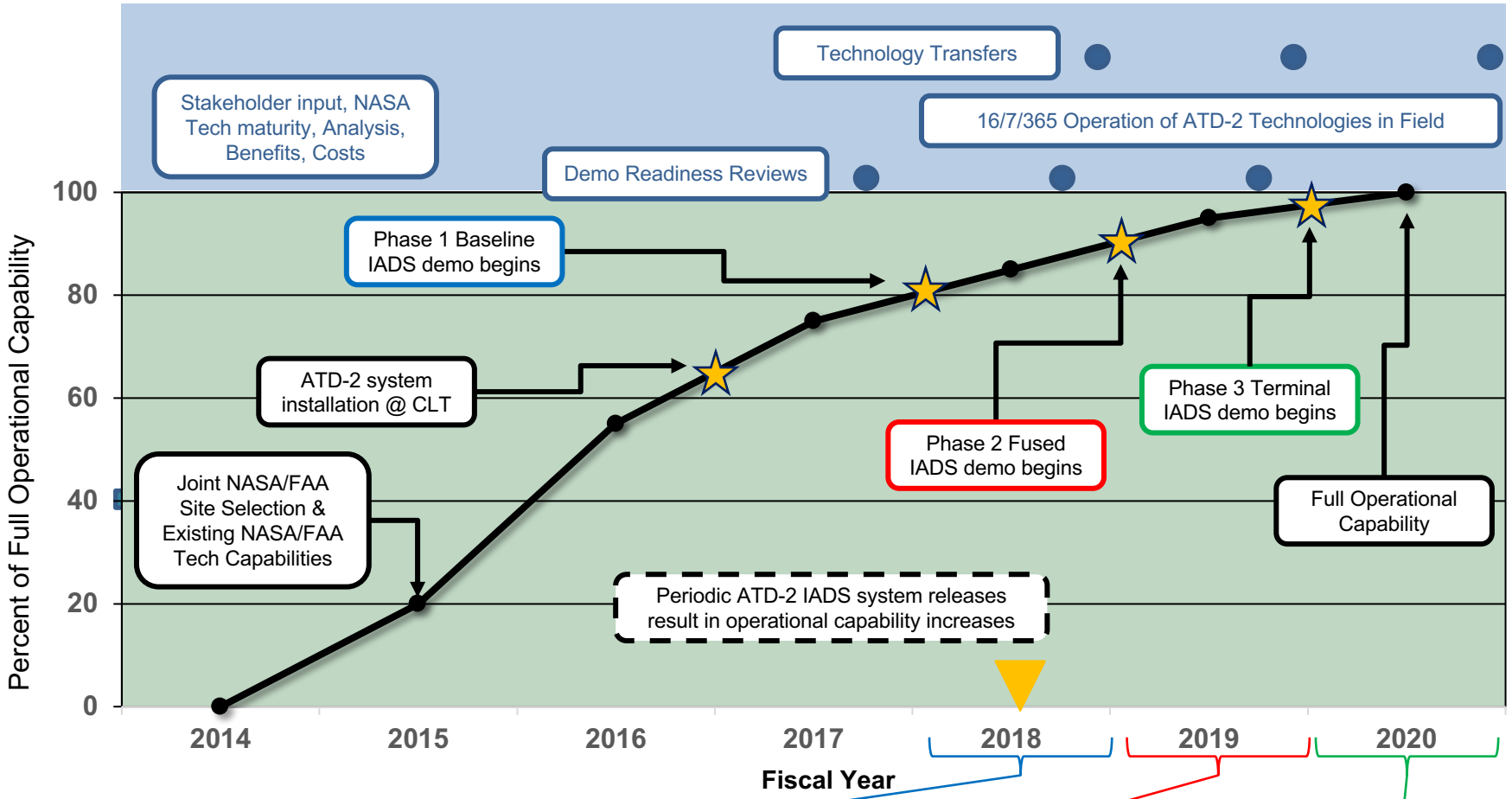
- **DEVELOP** an integrated arrival/departure/surface (IADS) prediction, scheduling and management system for a metroplex environment
- **ENABLE** use of collaborative decision-making that is consistent with FAA's Surface Collaborative Decision Making (CDM) ConOps
  - through increased information sharing of prediction and scheduling information between airport, flight operator, and ATC
- **QUANTIFY** current day shortfalls and evaluate the system-level performance for benefits in terms of ***predictability***, ***efficiency***, and ***throughput***
  - using metrics established by NASA and stakeholders
- **DEMONSTRATE** the ATD-2 technologies in an operationally relevant environment with system capable of performing under continuous daily use
- **TRANSFER** an integrated set of technologies to the FAA, airlines, airports, and suppliers

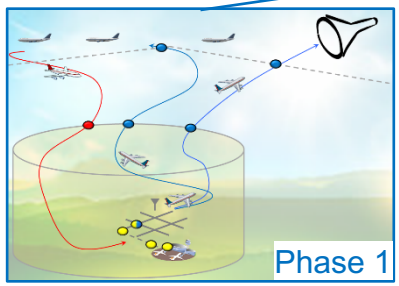
† paraphrase of ATD-2 Level 1 System Requirements

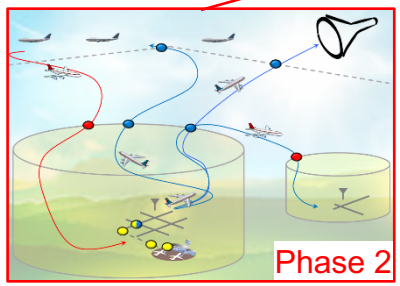
ATD-2 IADS Operational Environment

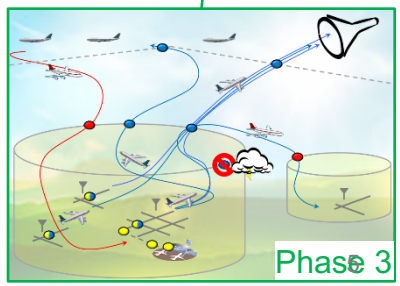


Field Demo Timeline









Just 6 months into initial phase. Many partnership opportunities ahead.

Agenda

- Introduction
- **IADS system architecture**
- IADS system capabilities
- Partnership opportunities

ATD-2 IADS System

Overview video online at: http://aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2.shtml

ATD-2 is Technology Integration

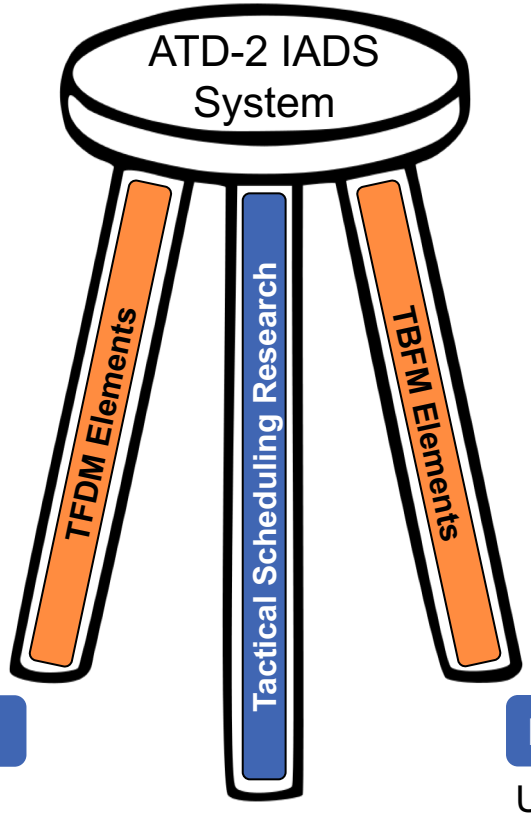
ATD-2 combines existing and emerging FAA technologies with technologies developed through NASA research to create an Integrated Arrival/Departure/Surface (IADS) traffic management system for the metroplex.

TFDM Terminal Flight Data Manager

Emerging tower tool with electronic flight data and Surface CDM capabilities

TBFM Time Based Flow Management

Existing en route tool for time based scheduling of arrivals and departure into constrained flows



SARDA Spot and Runway Departure Advisor

Tactical surface modeling and scheduling plus user interfaces for ramp area traffic management

PDRC Precision Departure Release Capability

Uses trajectory-based surface information to improve en route tactical departure scheduling

ATD-2 IADS Logical Architecture

ATD-2 Internal Systems

by NASA | by FAA | by Others | Phase 3

Surface Trajectory Based Operations

- Airport Resource Management
- Flight TMI Service
- Surface Scheduler
- Surface Modeler
- Traffic Flow Data
- Strategic Planning Tools
- Electronic Flight Data
- IDST Web Services Proxy
- Surface Situational Display
- TFDM SWIM Engine
- Comm. Manager

Metroplex Coordinator

- Planning & Collaboration Engine
- Multi-System Restriction Manager
- Metrics, Reporting & Analysis
- Event Based Surface Scheduler
- Schedule Orchestrator
- Multi-airport Web Display
- Terminal Resource Manager
- What-If Resolver

Real-time Infrastructure

- Message Bus
- Real-time Repository
- DASH

Support Systems

- System Startup
- Adaptation
- Analysis Framework
- Data Warehouse

Time Based Flow Management

- Comm. Manager
- Dynamic Planner
- SWIM Data Interface
- Timeline GUI
- Trajectory Synthesizer
- Plan-view GUI
- Input Source Manager
- Route Analyzer
- IDAC Web Services Routing Tool

External interfaces via SWIM and SWIM extensions

ATD-2 External Systems

Air Carriers

- EOBT Calculator
- SWIM Ingest
- Airline Processing
- RTC Display

Airport Authority

- SWIM Ingest
- Airport Processing

Industry

- SWIM Ingest
- What If

Stakeholders

- SWIM Ingest

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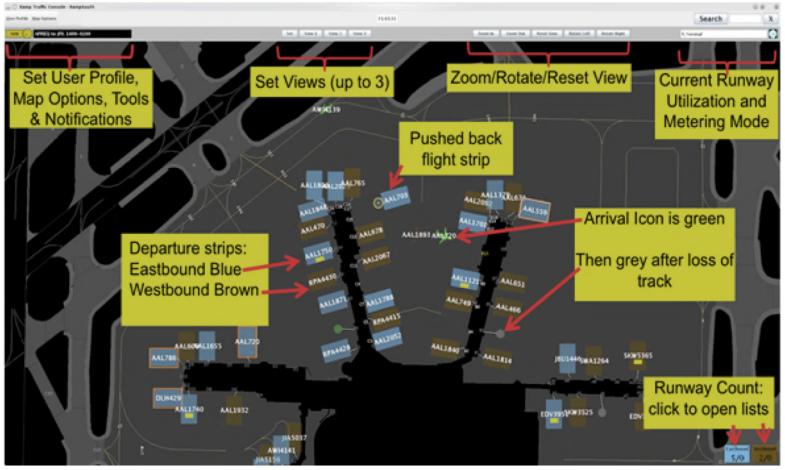
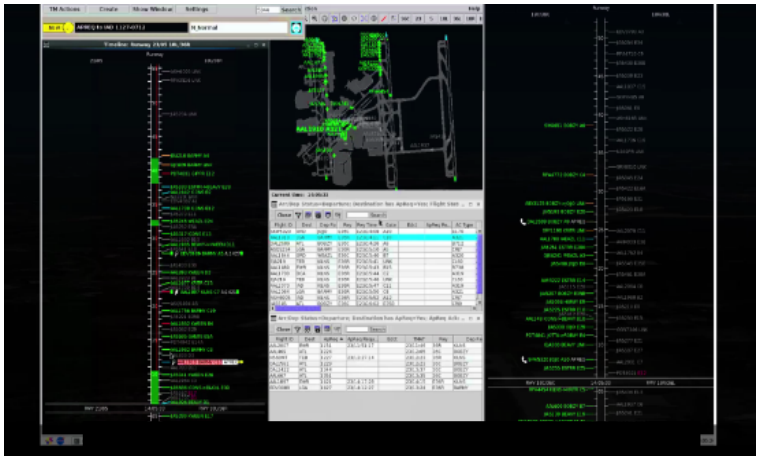
ATD-2 IADS User Interfaces

ATD-2 is a ***field demonstration*** that evaluates the benefits of ***wholistic consideration*** of arrival, departure and surface (***IADS***) traffic flows while introducing new technologies and procedures into its ***collaborative operational environment***

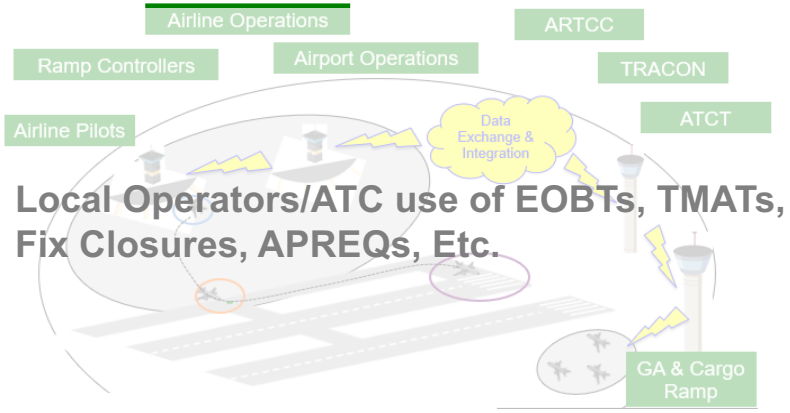
Collaborative Surface Metering w/Ramp Tool



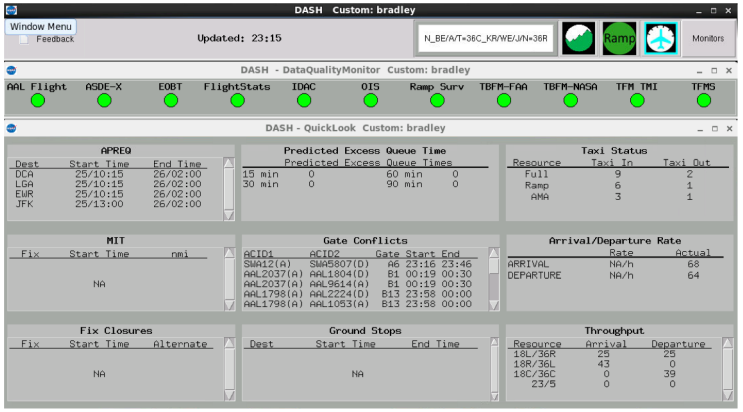
Overhead Stream Operational Integration



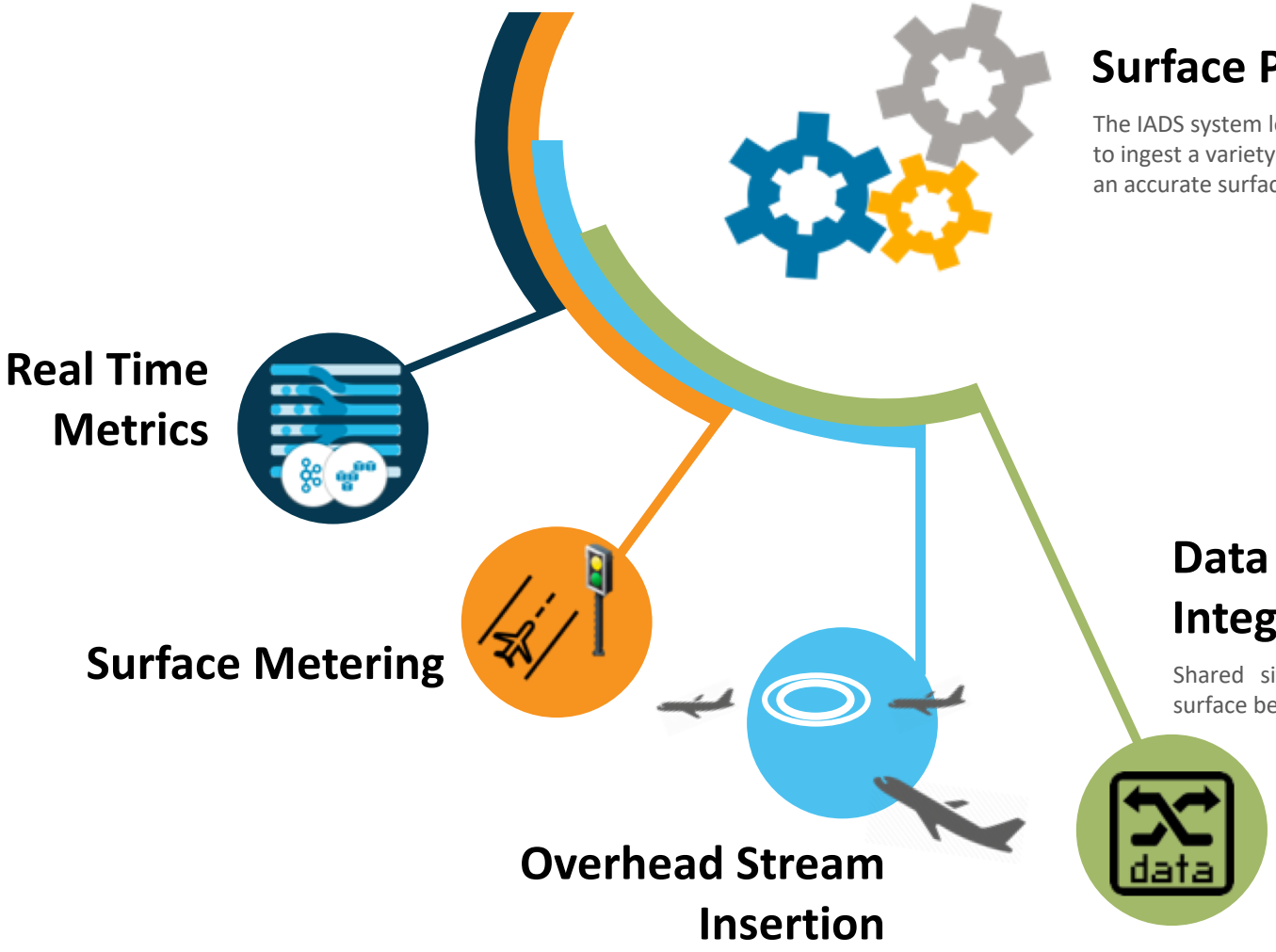
ATC/Operator Data Exchange and Integration



Collaborative Planning the Real-Time Flow



IADS Phase 1 Capabilities



Surface Predictive Engine

The IADS system leverages a surface predictive engine to ingest a variety of data feeds and inputs to produce an accurate surface model and associated schedule

Data Exchange and Integration

Shared situational awareness across the airport surface between ATC and operators

IADS Phase 1 Capabilities

Surface Predictive Engine

The IADS system leverages a surface predictive engine to ingest a variety of data feeds and inputs to produce an accurate surface model and associated schedule

Real Time Metrics

Surface Metering

Overhead Stream Insertion

Data Exchange and Integration

Shared situational awareness across the airport surface between ATC and operators

Automation Assisted Capacity Prediction

ATC TMC Runway Utilization Intent

TRACON controller runway intent

Highly accurate TBFM de-conflicted ON time estimate

TFM SWIM ETAs

TMIs. Controlled Take Off Times (CTOT)

Carrier provided EOBTs

Tactical airline intent (ramp controller)

Surface Automation Assisted **Capacity** Predictions

Surface modeling logic

- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Hovering logic

Scheduling Logic:

- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

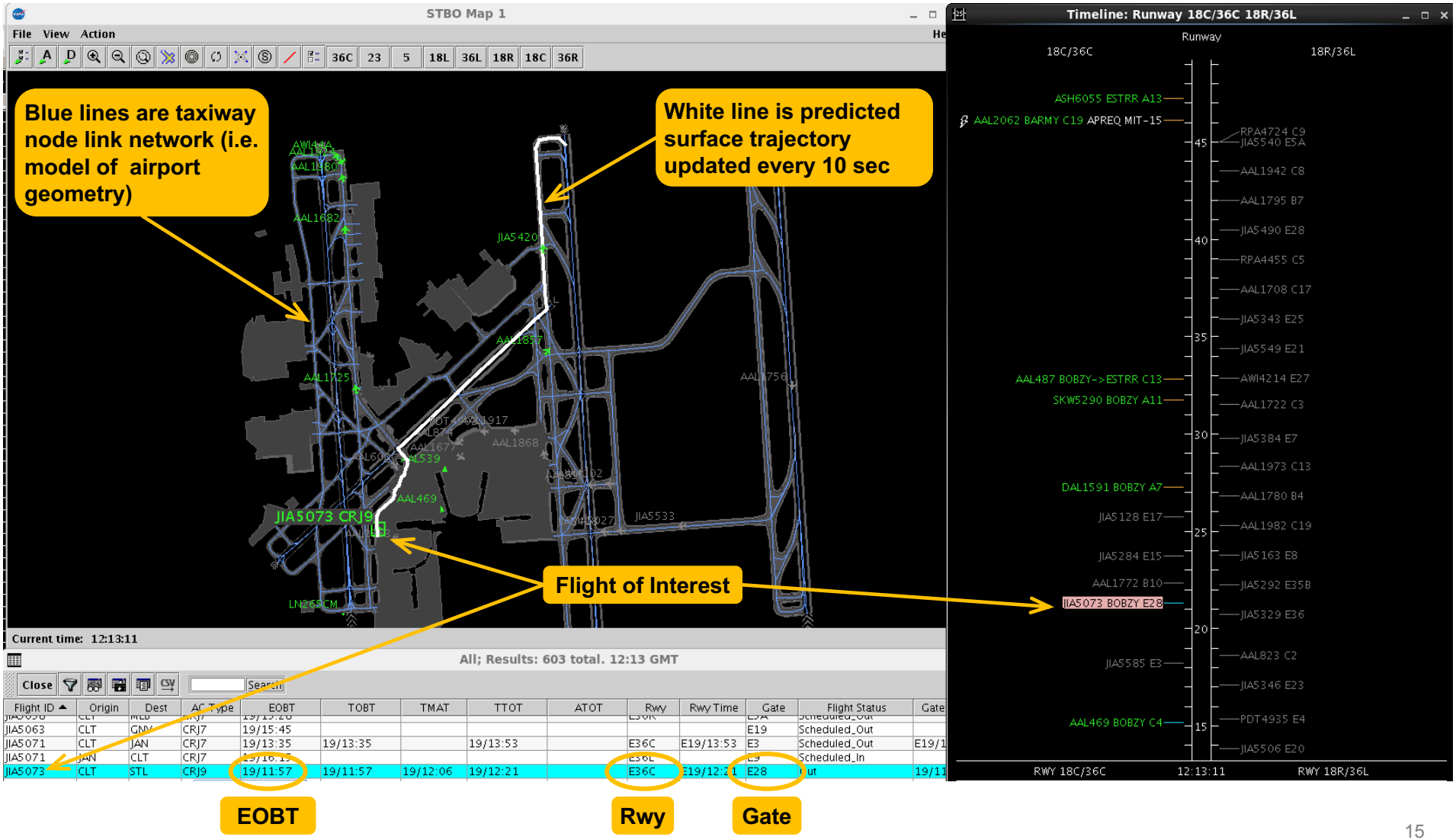
Capacity predictions are calculated and automatically used in surface metering calculations without required manual user ADR input.

Helps answer the questions:

- How much runway capacity do I have for a specific flight, on a specific runway, at a specific time given the current runway utilization strategy?
- What queue time/length should this flight expect?

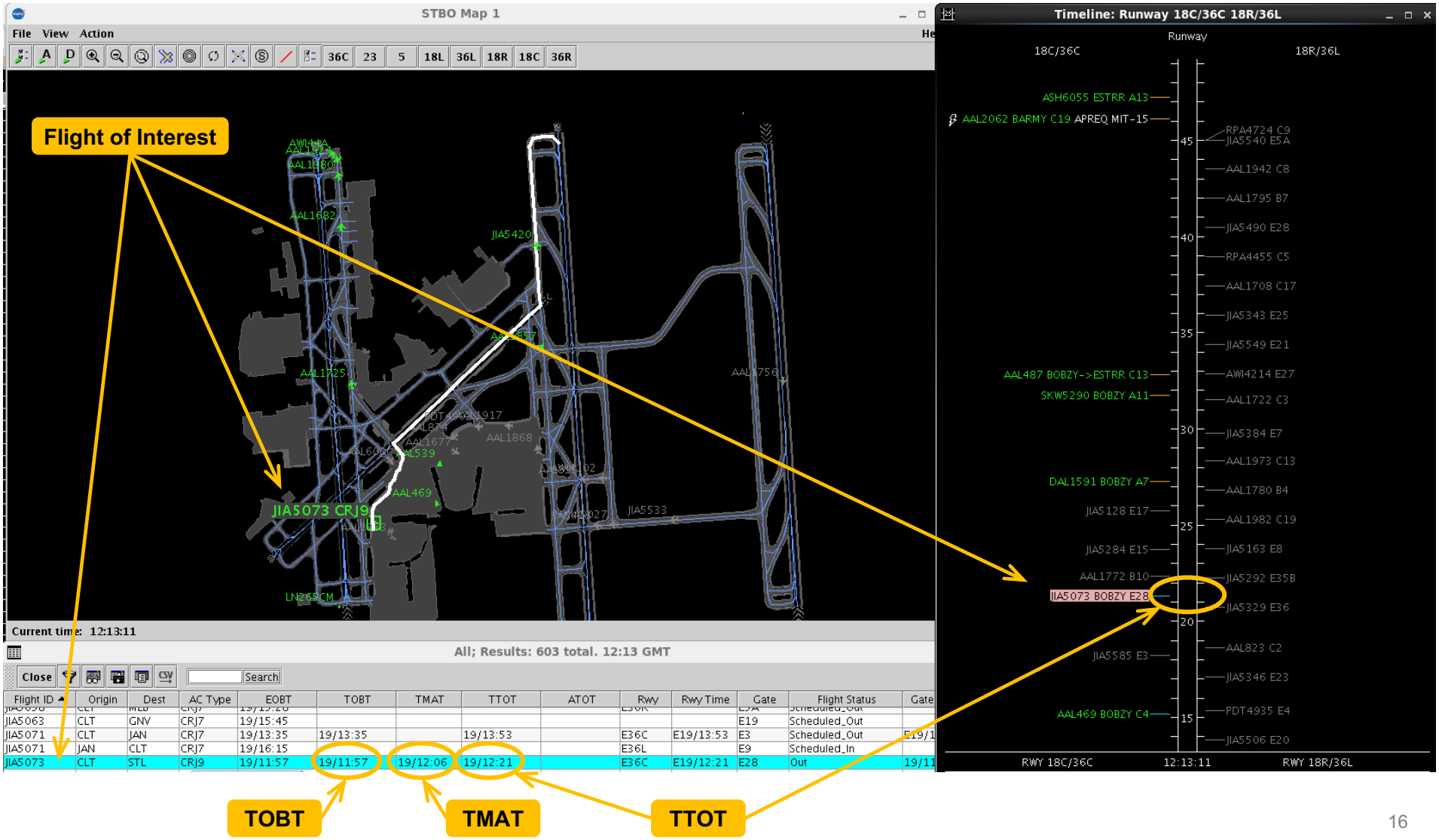
IADS Surface Modeling

The IADS surface modeler combines airport geometry with flight-specific intent and status information to produce continuously-updated 3D (x,y,t) surface trajectories for each flight.

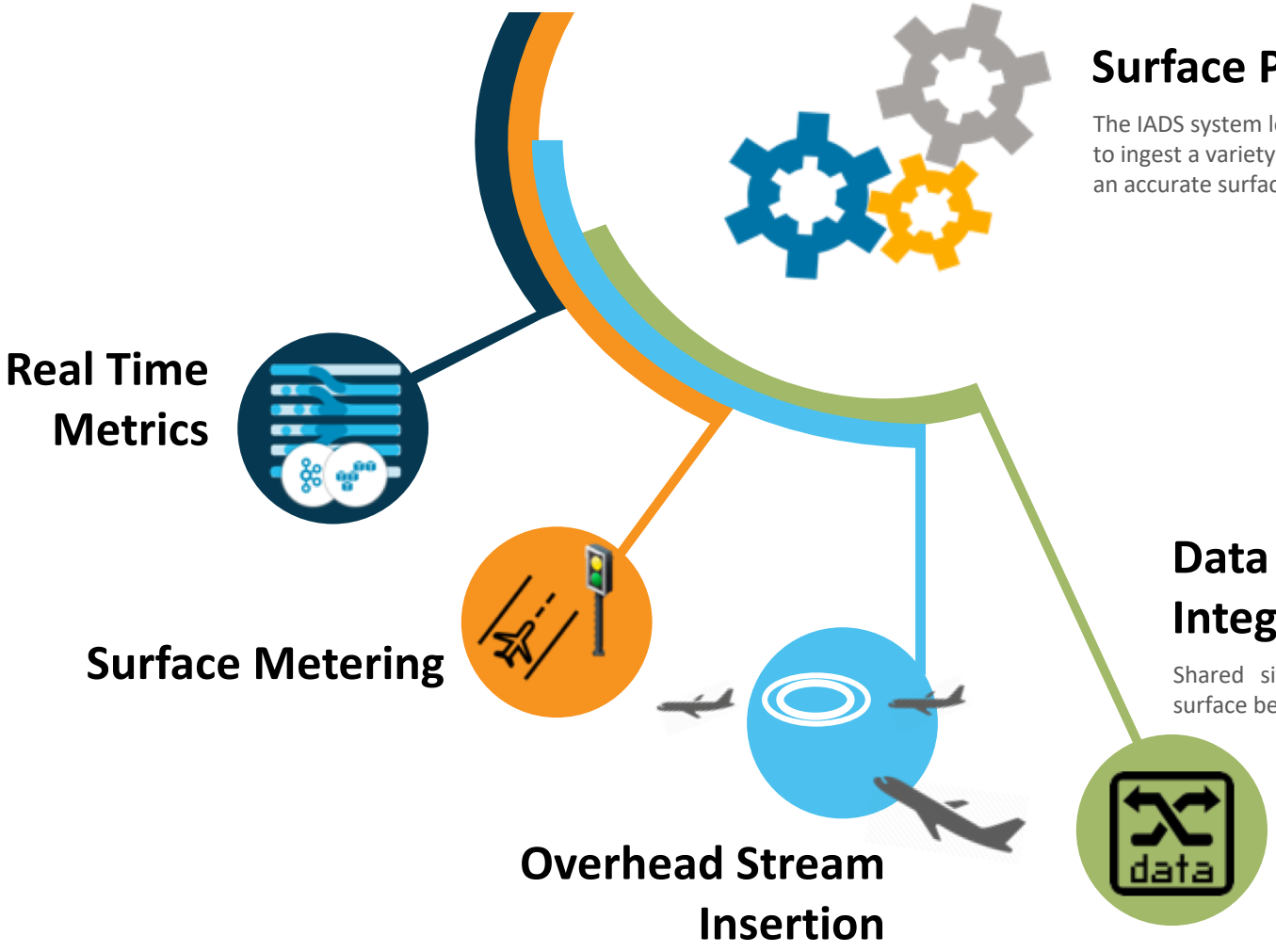


IADS Surface Scheduling

The IADS surface scheduler uses surface modeler inputs to produce target times for takeoff (TTOT), movement area entry (TMAT), and off block (TOBT)



IADS Phase 1 Capabilities



Surface Predictive Engine

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Data Exchange and Integration

Shared situational awareness across the airport surface between ATC and operators

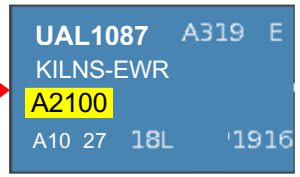
ATC/Operator Data Exchange and Integration Foundational for Advanced Surface Capability

ATD-2 Integrated Arrival/Departure/Surface

ATC to Operator

Displayed in Ramp Operations

APREQ

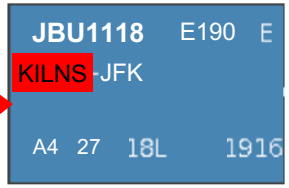


APREQ & EDCT

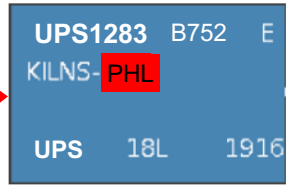
MIT

ATC Runway Change

Dep Fix Closure

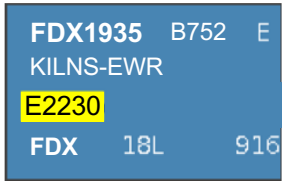


Airport Stop



Dep Fix CDR

EDCT



Better gate conflict information

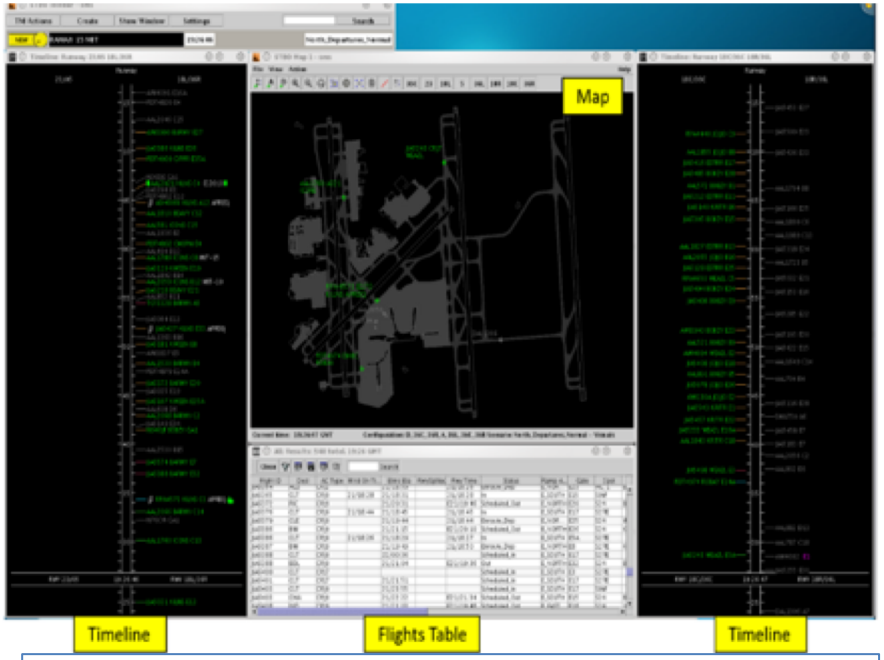
Better runway intent information

Operator to ATC

ATC Use of Earliest OFF Block Times (EOBT)

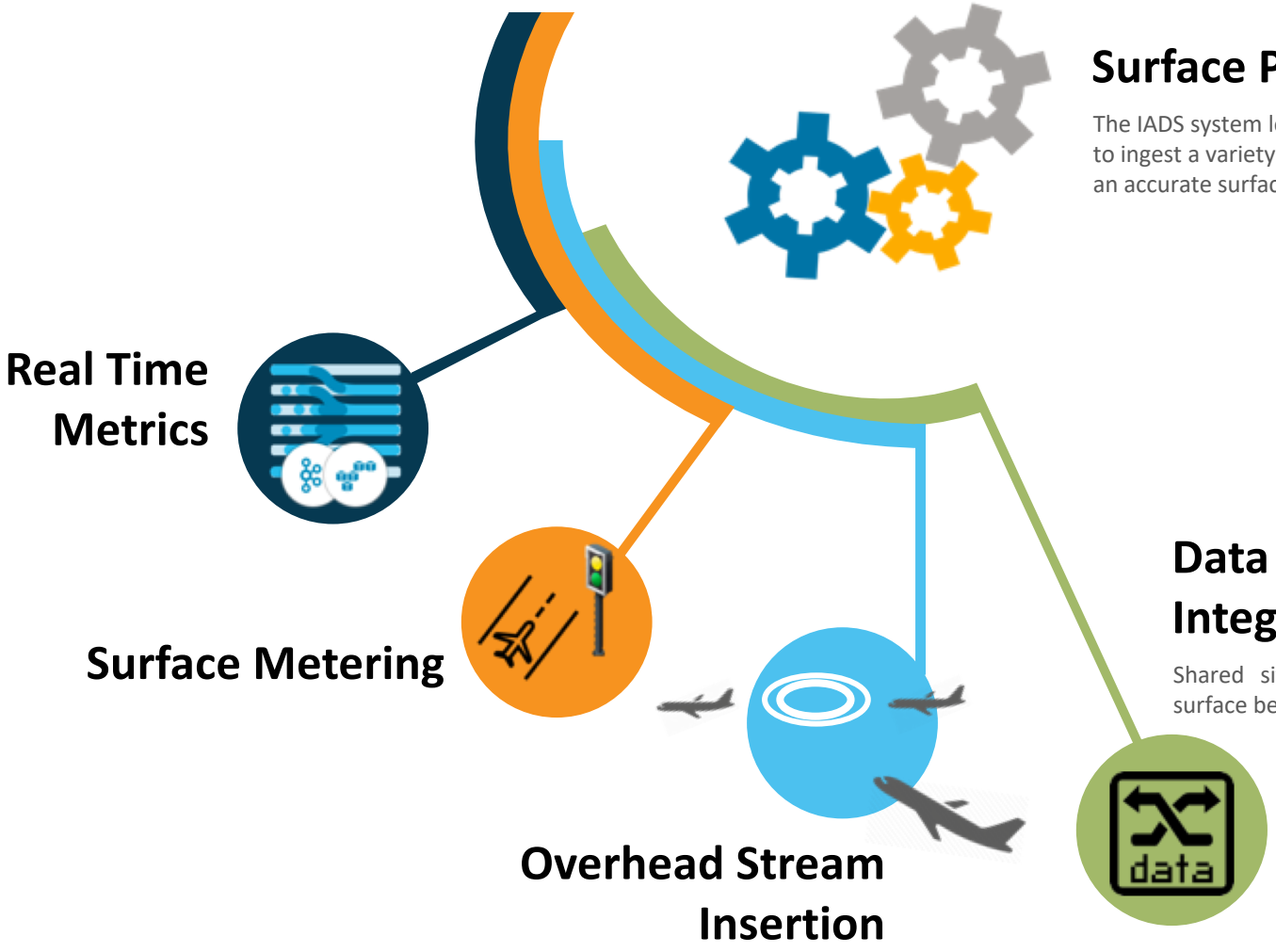
EOBT prediction accuracy increases at:

- 10m prior. 40.9% more accurate w/17.6% more predictability
- 15m prior. 27.8% more accurate w/8.7% more predictability
- 20m prior. 35.1% more accurate w/6.7% more predictability
- For 25 minutes and greater. EOBTs are same as legacy



TMC Planning Display with Traffic Forecast

IADS Phase 1 Capabilities



Surface Predictive Engine

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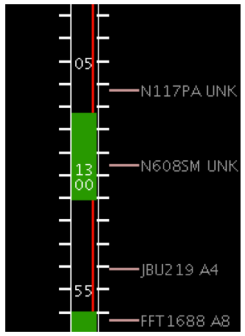
Data Exchange and Integration

Shared situational awareness across the airport surface between ATC and operators

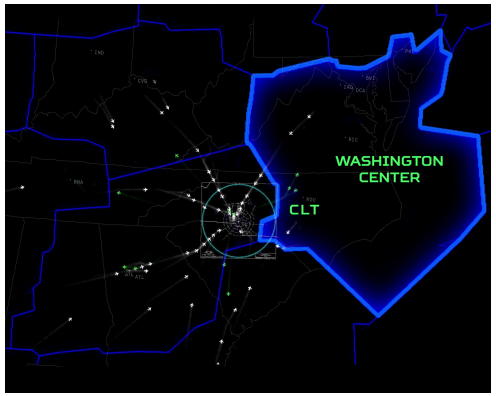
Collaborative Nature of Overhead Stream Insertion



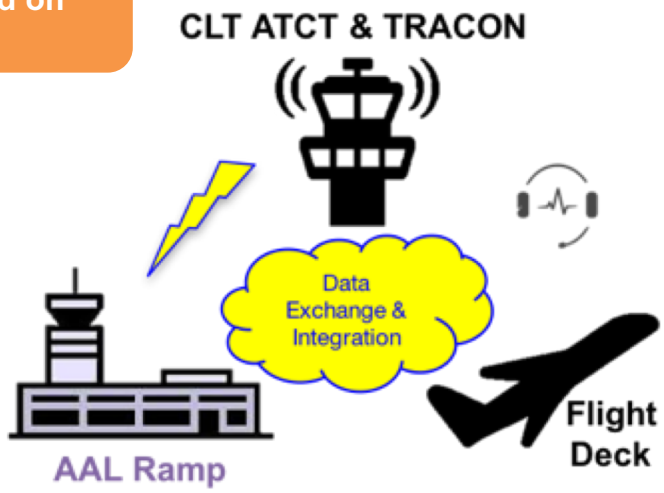
2) TMC electronically negotiates with ZDC for a time based on red/green space

IDAC-style scheduling between IADS at CLT and TBFM at ZDC

Washington ARTCC (ZDC)



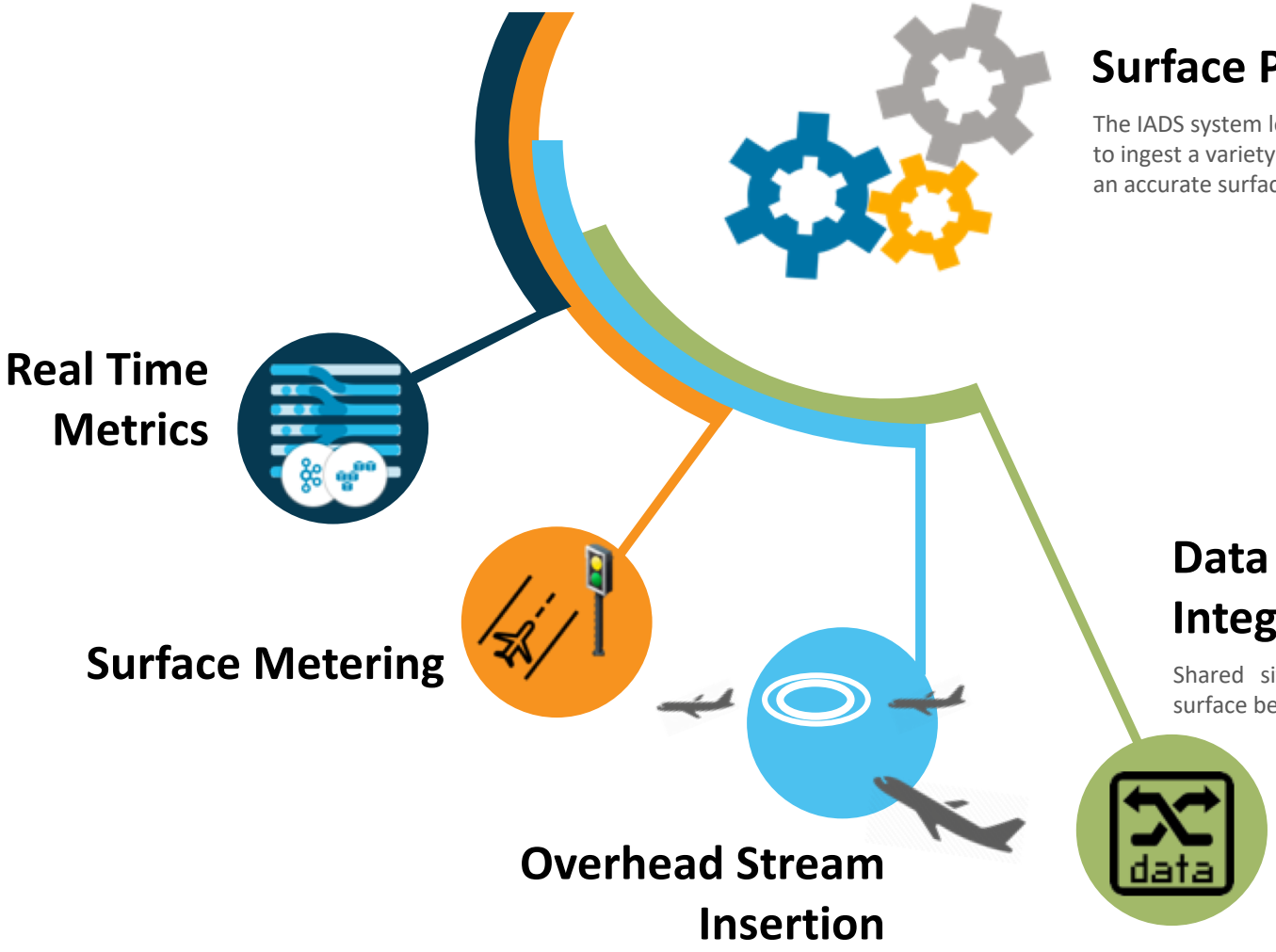
3) ZDC TMC approves or adjusts the time based on center constraints



4) Ramp utilizes the now visible APREQ time on their strips and pushback advisories

1) Pilot calls into clearance delivery approximately 10 min prior to push back for APREQ times

IADS Phase 1 Capabilities



Surface Predictive Engine

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Data Exchange and Integration

Shared situational awareness across the airport surface between ATC and operators

Surface Metering Process Flow Overview

ATD-2 Integrated Arrival/Departure/Surface

1 Generate Demand and Capacity Predictions

ATC TMC Runway Utilization Intent

TRACON controller runway intent

Highly accurate TBFM de-conflicted ON time estimate

TFM SWIM ETAs

TMIs. Controlled Take Off Times (CTOT)

Flight Operator Provided EOBTs

Tactical airline intent (ramp controller)

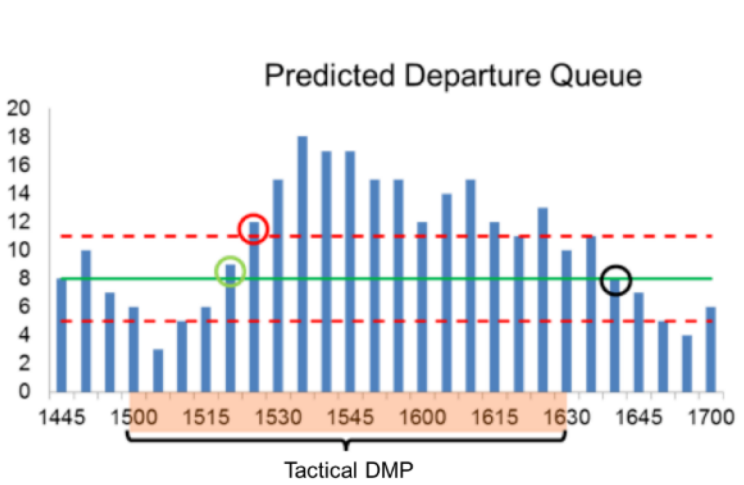
Surface Predictive Engine

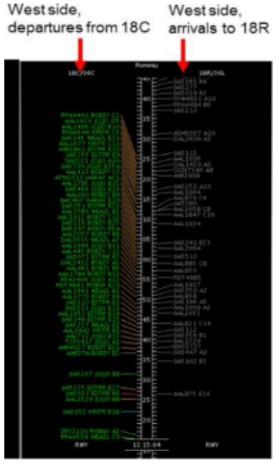
(Updates every 10 seconds)

Surface modeling logic
- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Trajectory hovering logic

Scheduling Logic:
- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

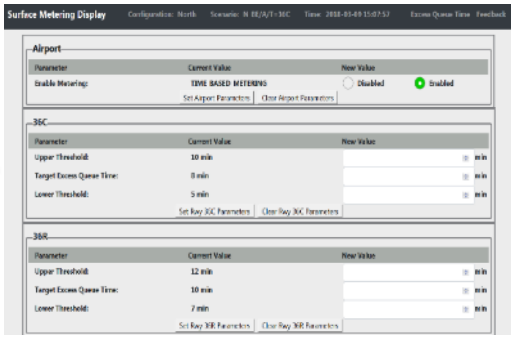
2 Monitor Surface Demand Capacity Imbalances





"What If" available. If Surface Metering, Go to Step 3

3 Enable Metering. Set Hold Level

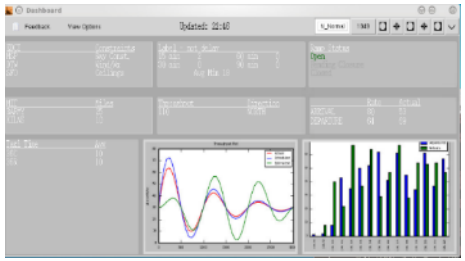


4 Honor TOBT and TMAT advisories

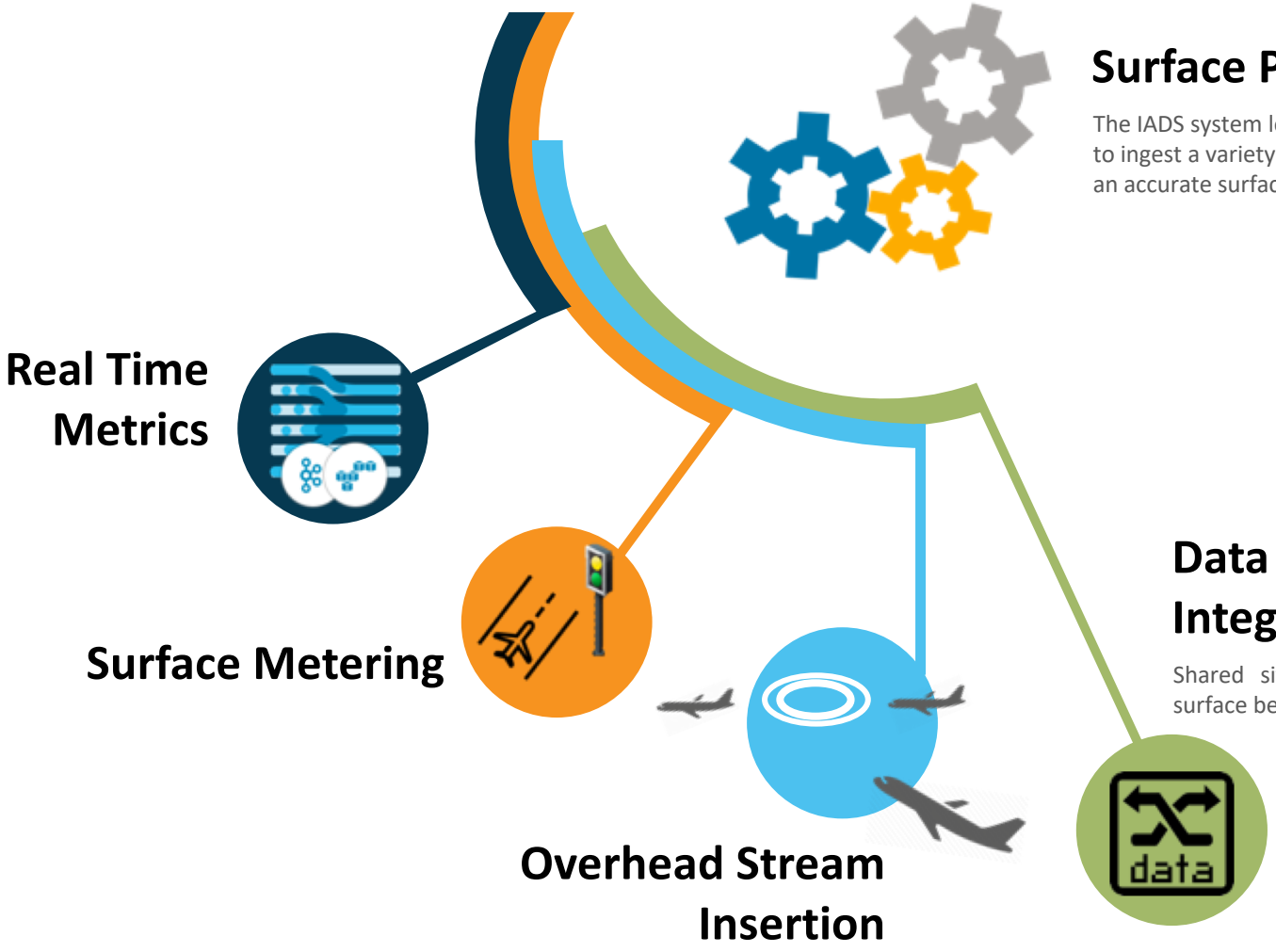
TOBT Advisory

TMAT Advisory

5 Evaluate Metering Effectiveness



IADS Phase 1 Capabilities



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Data Exchange and Integration

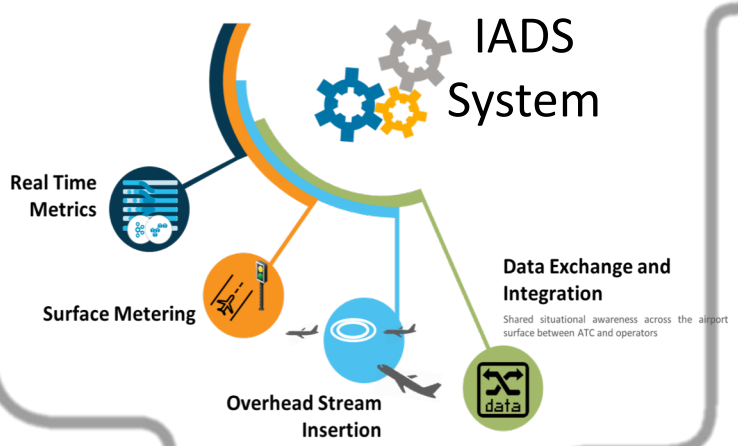
Shared situational awareness across the airport surface between ATC and operators

IADS System Benefits

15% improvement in the number of fights departing within their airline-scheduled departure block times

Average of 1.7 minutes taxi out time saved reducing AMA congestion

11.25 hours of delay saved each month by electronically renegotiating a better overhead stream slot



1,000 pounds of fuel saved during each metered departure bank

Reduces emissions by up to 3,000 pounds each bank which is equivalent to planting 36 urban trees

Greater visibility and coordination of flow programs enables better management of controlled times at the gate

Looking Ahead

Phase 2 Development
Fused IADS Demonstration

Agile Development Process
Continued engagement with field demo partners to evolve the system

Foundational Groundwork for Phase 3
Leveraging IADS in North Texas

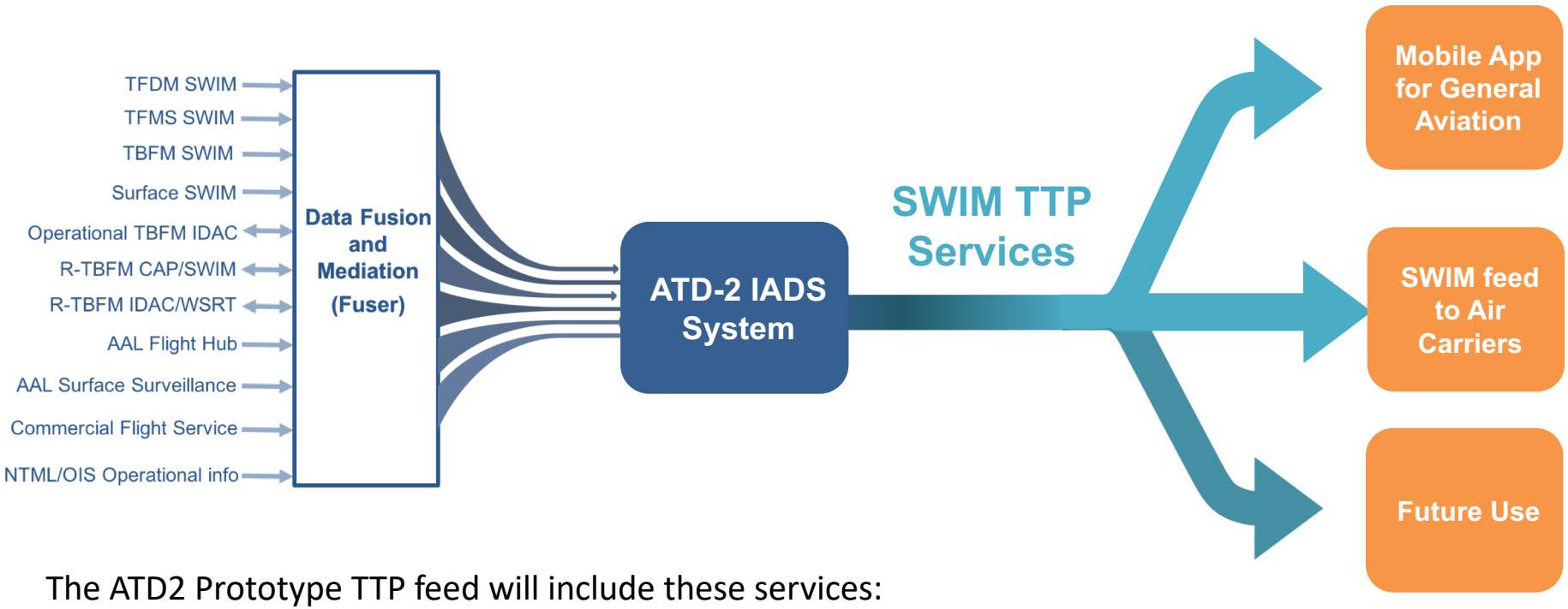
Leveraging Operational Data
Iterating with Field Demo Partners to address metrics needs

Agenda

- Introduction
- IADS system architecture
- IADS system capabilities
- **Partnership opportunities**

IADS Data Sharing via Prototype TTP

NASA and the FAA are collaborating to provide a prototype TFDM Terminal Publication (TTP) feed via SWIM R&D network as part of the ATD-2 Field Demonstration

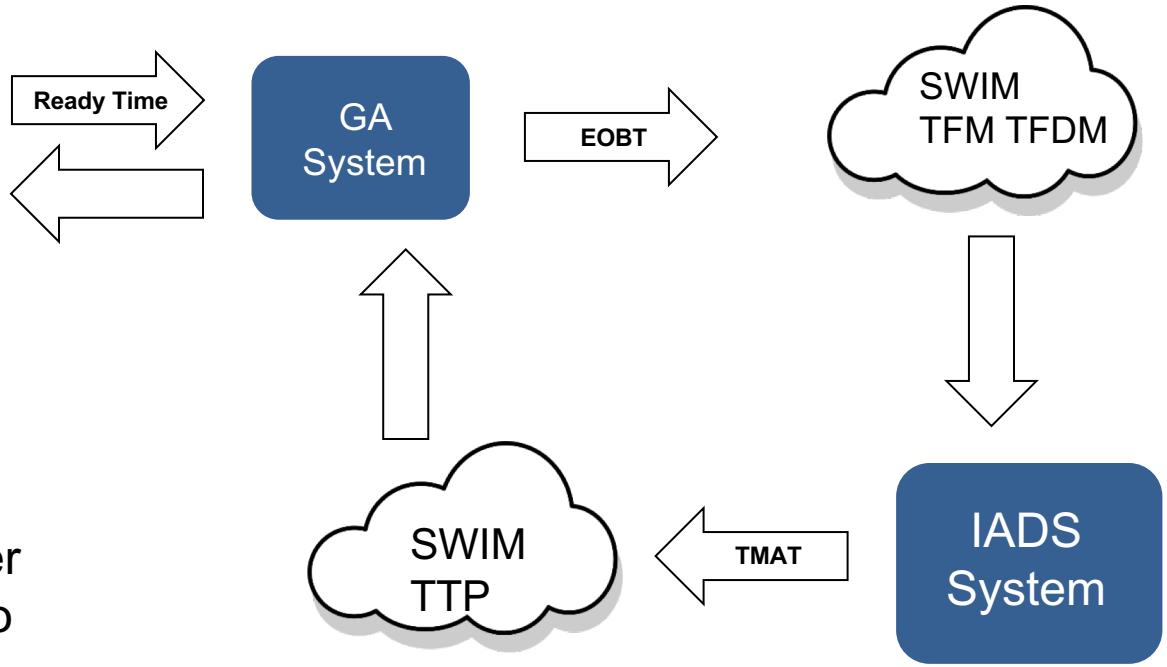


The ATD2 Prototype TTP feed will include these services:

- Flight Data
- Airport Information
- Traffic Management Restrictions
- Flight Delay
- Operational Metrics

IADS Data Sharing via Mobile App

Pilots submit a ***Ready-to-Taxi Time (RTT) / Earliest Off-Block Time (EOBT)*** for each flight via Mobile App



Pilot can now tell passengers to either relax or get ready to leave

OR

- NASA, the FAA, and MITRE are collaborating to provide a prototype Mobile App for use during the ATD-2 Field Demo
- Objective is to refine concept and transfer to industry for further development

ATD-2 Notice of Opportunity

https://www.fbo.gov/spg/NASA/ARC/OPDC20220/ATD-2_Industry_Technology_Evolution_Collaboration/listing.html

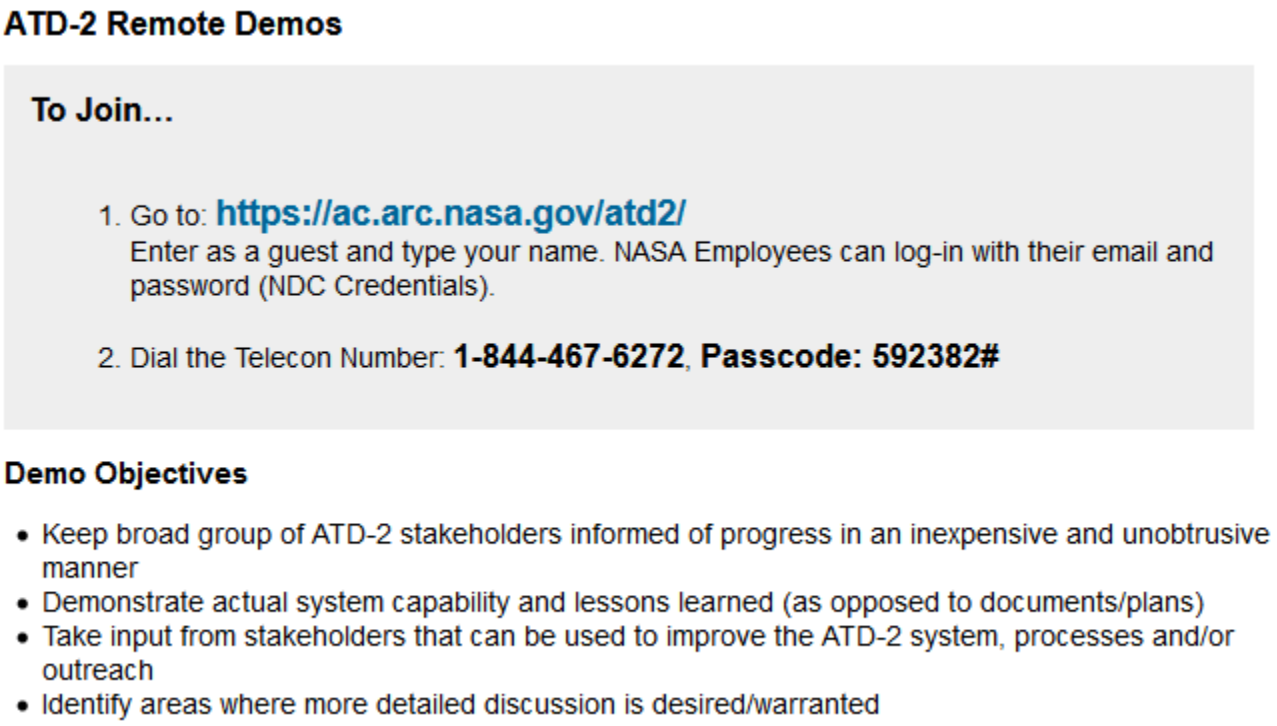
ATD-2 has posted a Notice of Opportunity on FedBizOpps

- Objective: Identify requirements for a successful technology transfer to industry
- Opened on Apr 6th
- Closes on May 11th
- May lead to collaboration enabled via Space Act Agreement (SAA)
- Not exclusive – technology transfer is not limited to partners entering into SAA

Remote Demos / Webinars

- Approximately one webinar per month
- Routinely host 60-80 attendees
- Six sessions recorded and available for replay
- Latest schedule, access info, and recorded sessions online at:

https://aviationsystemsdivision.arc.nasa.gov/research/atd2/remote_demos.shtml



ATD-2 Remote Demos

To Join…

1. Go to: **https://ac.arc.nasa.gov/atd2/**
   Enter as a guest and type your name. NASA Employees can log-in with their email and password (NDC Credentials).
2. Dial the Telecon Number: **1-844-467-6272**, **Passcode: 592382#**

Demo Objectives

- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
- Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach
- Identify areas where more detailed discussion is desired/warranted

Breakout Session Discussion

- Seeking input from industry regarding effective technology transfer
- What are the key barriers to effective technology transfer?
- What can NASA do to reduce these barriers?
- What specific collaboration topics are of value to industry?

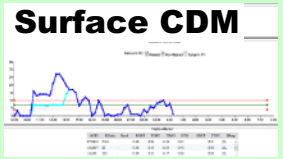
Backup

Phase 1: Baseline IADS Demonstration

- CLT ATCT control positions
- Baseline electronic flight data capability via TFDM EFD

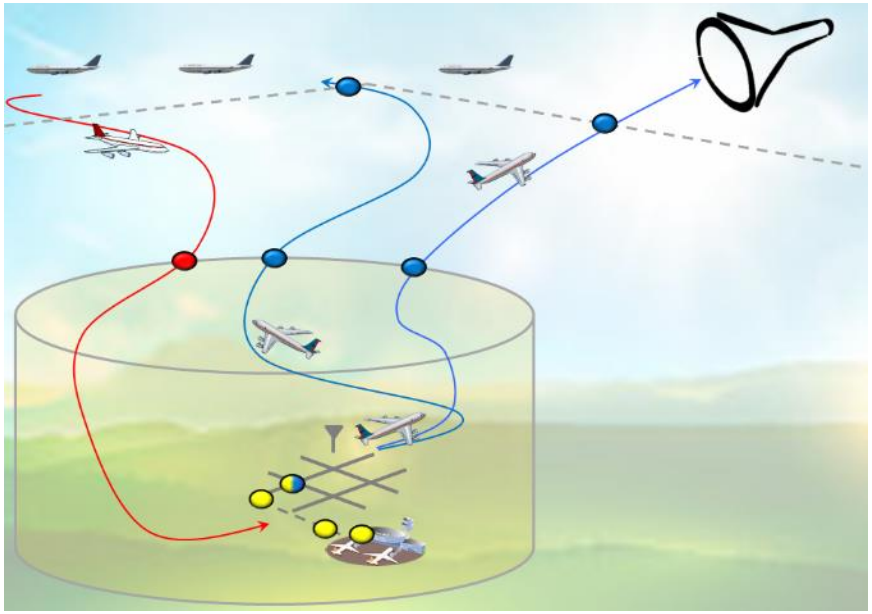
★

- AAL ramp controller and manager positions
- Tactical pushback advisories via RTC/RMTC display



- All positions as needed
- Predictive mode: strategic metering info for situational awareness and analysis

Surface Components



Phase 1 Demonstration Goals

- Evaluate the Baseline IADS capability
- Enhance American Airlines CLT “departure sequencing” procedure with ATD-2 surface tactical metering
- Demonstrate improved compliance for a significant percentage of tactical TMIs
- Mature strategic Surface CDM capability via operational use, analysis, and feedback
- Reduce ATCT workload by replacing paper strips with EFD

★

- CLT ATCT TMU position
- Tactical departure scheduling capability via STBO display

★

- ZDC TMU
- Tactical departure scheduling via modified TBFM/IDAC

Airspace Components

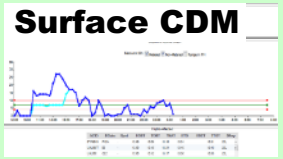
Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

★ = IADS user interface

Phase 2: Fused IADS Demonstration

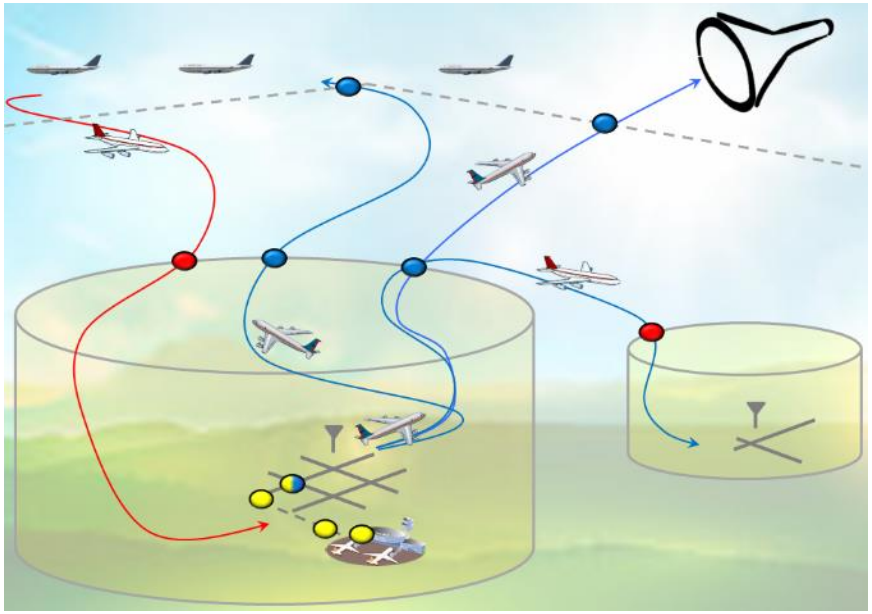
- Phase 1 capability plus:
- Include IADS info on EFD

- Phase 1 capability plus:
- Fused scheduler pushback advisories honor strategic TMATs



- Phase 1 capability plus:
- Prescriptive mode: strategic TMATs applied as constraints in fused scheduler

Surface Components



Phase 2 Demonstration Goals

- Evaluate the Fused IADS system capability
- Demonstrate benefits of strategic surface metering during periods of significant demand/capacity imbalance
- Enhance tactical surface metering to improve *non movement area* predictability and throughput
- Evaluate inclusion of IADS data on EFD
- Expand to demonstrate more scheduling scenarios for Washington and Atlanta Centers

- Phase 1 capability plus:
- Improvements as needed

- Phase 1 capability plus:
- Expand to ZTL TMU
- Integrate with arrival metering

- CLT TRACON TMU
- ATD-2 UI for TMI entry and situational awareness

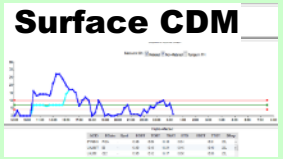
Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

Phase 3: Metroplex IADS Demonstration

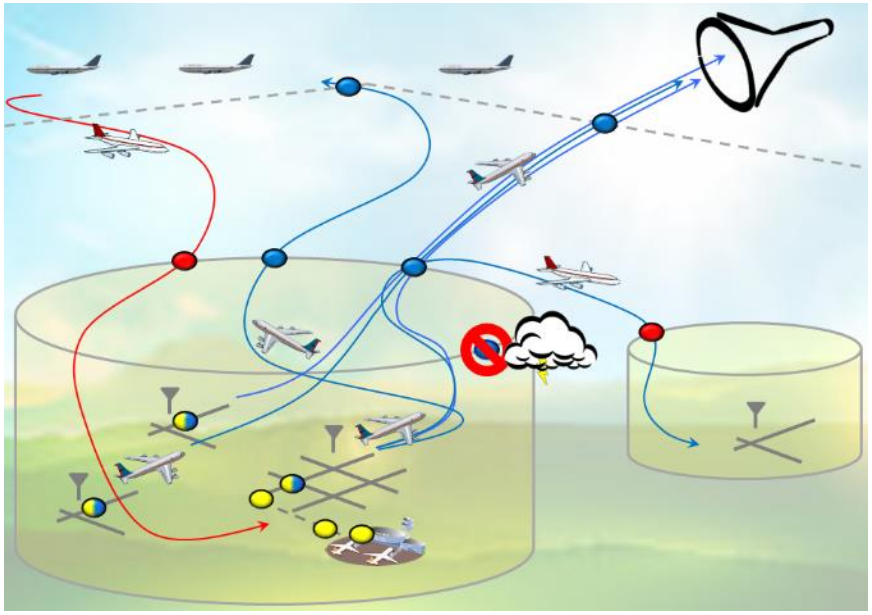
- Phase 2 capability plus:
- Integrate EFD with ATD-2 scheduling and metering

- Phase 2 capability plus:
- Improvements as needed



- Phase 2 capability plus:
- Improvements as needed

Surface Components



Phase 3 Demonstration Goals

- Evaluate the Metroplex IADS system capability
- Integrate EFD with ATD-2 scheduling
- Mature and enhance core ATD-2 capabilities
- Enhance CLT tactical surface metering to improve *movement area* predictability and throughput
- Reduce delay and increase throughput under Metroplex departure constraints *[NOTE: Metroplex Coordinator to be demonstrated for DFW TRACON (D10) environment via HITL or field experiment]*

- Phase 2 capability plus:
- Improvements as needed

- Phase 2 capability plus:
- Improvements as needed

- Phase 2 capability plus:
- Metroplex coordinator implemented for DFW TRACON (D10) environment

Airspace Components

Interfaces to external systems via SWIM plus ATD-2 SWIM extensions